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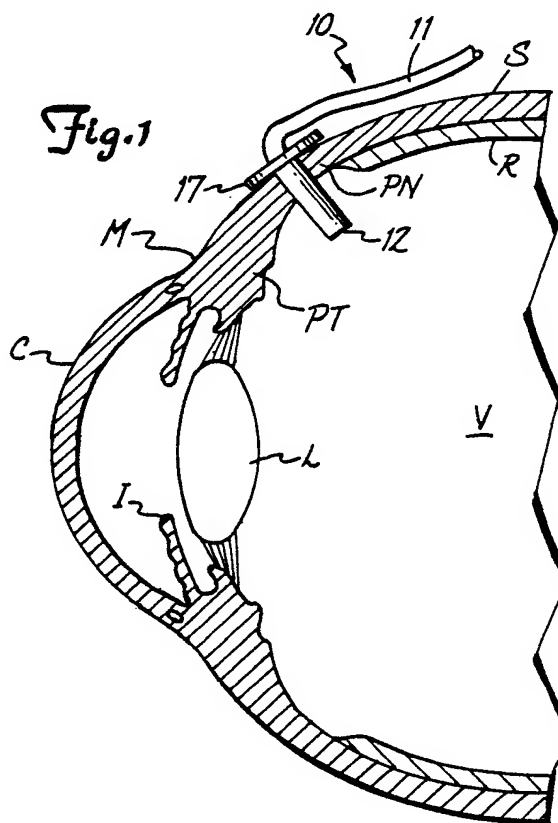
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Tissue-implantable fluid-dissipating device.

A tissue-implantable fluid-conducting device particularly useful in conducting fluids into and/or away from cavities in the eye. In one embodiment, the invention provides an infusion cannula (10) for delivering fluids to cavities of the eye. The cannula includes a tube (11) having first and second ends - (12, 13) and a check valve therebetween for allowing fluid flow only toward said first end. Means is provided at the second end for attaching the cannula to a fluid source, such as a glaucoma alleviation device, a drug infusion device, or other fluid sources. The cannula may also include a compressible reservoir. In another embodiment, the invention relates to a fluid dissipating device enabling fluid from a source to be delivered to and absorbed by tissue of the eye. The device includes a housing having walls defining an interior cavity, the walls having sufficient rigidity to prevent substantial collapse of the cavity when implanted, orifice means communicating with the cavity to allow fluid transfer from within the cavity to surrounding fluid resorptive tissues, and tube means communicating with the cavity to conduct fluid from a source to the cavity.



TISSUE IMPLANTABLE FLUID CONDUCTING DEVICE

FIELD OF THE INVENTION

The invention relates to the field of ophthalmology, and particularly to devices and methods for conducting fluids within the eye.

BACKGROUND OF THE INVENTION

In a variety of ophthalmologic procedures, treatments, and research, it is desirable to conduit fluids into, away from, or about the eye or spaces within the orbit of the eye. For example, it is frequently desirable to provide repeated and/or prolonged drug delivery into or around the eye. In the past, drug delivery techniques have involved implanting in the eye osmotic mini-pumps attached to silastic tubing. See, e.g., Miki, "A Method for Chronic Drug Infusion into the Eye", 28 Jap. J. of Ophthalmol., 140 (1984); Eliason, "An Ocular Perfusion System", 19 Invest. Ophthalmol. Vis. Sci., 102 (1980); Michelson, "Experimental Endophthalmitis Treated with an Implantable Osmotic Minipump", 97 Arch. Ophthalmol., 1345 (1979); and Miki, "Intraocular Cannula for Continuous, Chronic Drug Delivery", 103 Arch. Ophthalmol., 712 (1985).

All of these devices, however, require the implantation of a mini-pump which must be designed and prepared to deliver a specific predetermined drug desired. These devices are large and cumbersome to attach to the eye for even a few days. They give only a slow, constant infusion, being incapable of delivering a bolus, or of delivering selectively different drugs over an intermittent time period. Furthermore, such devices depend upon the presence of a pumping pressure to prevent reflux of fluid out of the cavity into which the drug is being infused. If the pump becomes detached, either purposely or accidentally, there is no mechanism to prevent extrusion of ocular fluids, potentially causing loss of pressure in and damage to the eye.

If the discharge end of a drug delivery tube is placed in a subconjunctival space but not intraocularly, healing of the tissue around the end frequently results in scarring, rendering the space non-absorbent or substantially less absorbent of fluid. This problem is also encountered with devices designed to drain excess aqueous humor from an eye having glaucoma (elevated intraocular pressure), thereby inhibiting fluid flow and causing ocular pressure to rise to potentially dangerous

levels. An excellent account of the history of glaucoma surgery is found in Bick, Use of Tantalum for Ocular Drainage, Arch. Ophthalmol., 42:373-388 (1949).

In one prior art device, the exterior end of a tube extending through the wall of the eye is provided with a pressure relief valve in the form of small slits made through the wall of the tube at its end. Reference is made to Krupin, T., et al, Valve Implants in Filtering Surgery, Am. J. Ophthalmol., 81:232-235, (1976). It is reported that fairly close control over the pressure needed to open the valve may be obtained. If the exterior or distal end of the tube is inserted beneath a flap of conjunctiva or the like, of course, the valved tube is subject to the same drawbacks as the other tubes described above.

Glaucoma surgeons have discovered that when surgery fails it is usually because the "bleb", the subconjunctival drainage space created by the surgeon, has become fibrosed, causing it to shrink and become non-absorbing.

One device that has been somewhat successful in maintaining the fluid absorbency of the bleb during the healing process was described by Molteno in 1969. Molteno, "New Implant for Drainage in Glaucoma", British J. of Ophthalmol., Vol 53, p. 161 (1969). Molteno's device was made from a "stellon" brand acrylic monomer. The device consisted of two parts--a flat plate fashioned to conform to the sclera and a gutter incorporated at the point where a drainage tube met the plate to assure an even spread of drainage into the bleb. In 1979, Molteno disclosed a new device that had a biconcave base plate and a long silicone tube, which served the same function as the first device. Reference is made to Chapter 11 of Glaucoma Surgery by Luntz, M.H., Harrison, R., and Schenker, H.I. (1984), for a description of this device.

A need exists in the medical field for a tissue-implantable device which would operate substantially on a continuous basis to permit fluids to be infused and/or drained into and around the eye but would not be subject to the drawbacks associated with healing and scarring of tissue or the complications associated with prior implantable pumps.

SUMMARY OF THE INVENTION

The invention, in one embodiment, provides an infusion cannula for delivering fluids to various cavities of the eye. The cannula comprises a tube having first and second ends and a check valve therebetween for allowing fluid flow only toward

said first end. Means is provided for securing the first end within the eye, and means is provided at the second end for attaching the cannula to a fluid source, which may be a glaucoma alleviation device, a drug infusion device, a hilt for receiving a tube from an infusion pump, or even a rubber plug for receiving a hypodermic needle or similar device. The cannula may also include a compressible reservoir and/or a plurality of one way check valves. The reservoir further may be adapted to receive a hypodermic needle directly therein.

In another embodiment, the invention relates to a method of delivering fluid to various cavities in the eye, comprising the steps of providing an infusion cannula having first and second ends and a check valve therebetween to allow fluid flow only toward said first end; surgically inserting the first end of the cannula into the eye; attaching a fluid source to the second end of the cannula; delivering fluid into the cannula; and detaching the fluid source from the second end of the cannula, whereby the check valve will prevent escape of any fluid through the cannula.

In yet another embodiment, the invention provides a tissue implantable, fluid dissipating device enabling fluid from a source to be delivered to and absorbed by tissue of the eye. The device includes a housing having walls defining an interior cavity, the housing walls having sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted, orifice means communicating with the cavity to allow fluid transfer from within the cavity to surrounding fluid resorptive tissues when the device is implanted, and tube means communicating with the cavity to conduct fluid from a source to the cavity, the cavity having an inner diameter substantially greater than any inner diameter of the tube means. The device preferably generally "floats" within the tissue pocket within which it is embedded. That is, the majority of the outer surface of the device confronts, but is not bound to, tissue which is absorptive of liquid escaping from the orifice.

When the latter embodiment of the invention is surgically implanted in the eye wall, one end of the tube means communicates with the cavity, the other end communicates with a fluid source such as an infusion drug source, or an apparatus receiving aqueous humor from the anterior chamber of the eye. A fluid reservoir, for example, may collect the excess eye fluid released from the anterior chamber, and reference is made to my United States Patent No. 4,554,918, the teachings of which are herein incorporated by reference. In operation, fluid flows through the tube means into the interior of

the cavity and thence outwardly through the orifice to be absorbed by fluid resorptive tissue facing the orifice, and desirably also tissue generally enveloping the implanted device.

The housing of the latter embodiment may be provided with a variety of configurations. In the preferred embodiment, however, the housing comprises a plate member and a hood member peripherally connected to the plate member to define a fluid-collecting, outwardly open cavity or pocket therebetween. Desirably the plate member is curved to fit the contour of the eye wall. An edge of the hood member typically extending arcuately over the plate member forms the orifice or mouth of the pocket opening. The radius of curvature of the hood member is less than the radius of curvature of the eye wall in order to form the pocket therebetween.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 is a cross-section of an eye showing a partially broken away view of the device of the invention implanted in the eye;

Figure 2 is a perspective, somewhat - schematic view of an eye showing an infusion device of the invention implanted therein;

Figure 3 is a broken away view of a modified embodiment of the invention;

Figure 4 is a broken away view of another modified embodiment of the invention;

Figure 5 is a broken away view of yet another modified embodiment of the invention.

Figure 6 is a broken away, schematic representation of an eye showing the positioning therein of a device of the invention;

Figure 7 is a broken away cross sectional view taken along line 7-7 of Figure 6;

Figure 8 is a broken away cross sectional view of another embodiment of the invention;

Figure 9 is a broken away cross sectional view taken along line 9-9 of Figure 8;

Figure 10 is a plan view of another device of the invention;

Figure 11 is a broken-away cross-sectional view taken along line 11 11 of Figure 10;

Figure 12 shows another embodiment of the invention;

Figure 13 shows a valve in cross-section and broken away, useful with a device of the invention.

BEST MODE OF CARRYING OUT THE INVENTION

Fig. 1 shows somewhat schematically a cross-section of the human eye including a device of the invention implanted therein. In that figure the cornea is designated "C"; the iris as "I", the lens as "L", the sclera as "S", the retina as "R", the pars plicata of the ciliary body as "PT", the pars plana of the ciliary body as "PN", the vitreous cavity as "V", and the limbus as "M". An infusion cannula device (10) of the invention is shown inserted through the pars plana of the ciliary body "PN" into the vitreous cavity "V".

One embodiment of the device is shown more fully in Fig. 2. The cannula (10) includes a tube (11) having a first end (12) inserted through the pars plana "PN" of the ciliary body into the vitreous cavity "V". As shown in Figs. 2, 4 and 5, the first end (12) may comprise a relatively rigid tube connectable to a more flexible tube (11). The rigid portion (16) facilitates implantation and affixation of the device. The second end (13) of the tube (11) includes a hilt (22) for connection to an infusion fluid source.

A one way valve (14) is disposed within the tube between its first (12) and second (13) ends. This valve is a check valve to allow fluid flow only in a direction toward the first end, in this case being in the vitreous cavity "V" of the eye. The device may further include a flange (17) which may be secured to the sclera "S" by sutures or other conventional means.

In one surgical procedure for implanting the device (10) the conjunctiva and Tenon's capsule is opened down to bare sclera. An incision is made through the sclera into the vitreous cavity, avoiding the retina if over the pars plana or more anterior. Following this, the first end (12) is threaded through the scleral wound, and the flange (17) is secured with sutures placed in the sclera. The conjunctiva is then closed about the tube with sutures, allowing the second end (13) to come out of the conjunctiva into the cul-de-sac and exiting between the eyelids to be taped or sutured to skin of the temple.

Preferably the device is implanted through the pars plana of the ciliary body, generally about 3mm from the limbus "M". Under appropriate circumstances, however, the device could also be implanted at the limbus or cornea into the anterior chamber, or through the retina into the vitreous cavity. As previously noted, and as will be described later in greater detail, the device may also be adapted to deliver fluid into any portion of the orbital spaces, subconjunctivally, subtenonally, or retrobulbularly.

Fig. 3 shows an alternate embodiment in which a rigid trochar (20) is first implanted through the pars plana of the ciliary body, and a flexible tube is thereafter inserted through the trochar (20). The trochar (20) may then be removed, and the tube connected to the balance of the infusion cannula device (10). This technique facilitates use of entirely flexible materials, reducing the likelihood of irritation to or erosion of the conjunctiva.

For patients requiring use of the device for only a relatively short period of time, (such as several days or a few weeks) the second end (13) of the device may be position forwardly, exiting the eye between the eyelids and temporarily affixed, for example, by adhesive tape to the temple or forehead of the patient. The second end (13) may include a hilt (22) which can be selectively connected to or disconnected from complimentary tubing from an infusion fluid source. Alternately, the second end (13) of the tube may comprise a solid rubber plug (23) adapted to receive fluid therethrough by injection from a hypodermic needle. In this embodiment, the tube may be small enough to position the second end (13) within the cul-de-sac of the conjunctiva. Such embodiment would be more suited to administration of infusion fluids over longer periods of time or when the patient is not hospitalized. This embodiment also has the advantage of being more aesthetically pleasing.

Fig. 5 shows another embodiment in which the device further includes a reservoir (25), and an optional second check valve (27). This embodiment is particularly suited to long term application of the device (for example, several weeks or months). When implanted, the second end (13) of the tube, which includes a rubber plug (23) for receiving a hypodermic needle, is positioned within the cul-de-sac of the conjunctiva. When administration of infusion fluid is desired, the physician inserts a hypodermic needle through the rubber plug (23) and fills the reservoir (25) with infusion fluid. The reservoir itself may be attached to the sclera "S" of the eye in a position to allow convenient digital manipulation to express the infusion fluid outwardly from the reservoir toward the first end (12) of the device (10). Alternately, the reservoir may be elastic, exerting a relatively contact compression force to slowly deliver the infusion fluid. The check valve or valves prevent reflux of the infusion fluid.

The device may be manufactured by any of a variety of well known suitable materials. Rigid portions of the device may be made from polymethylmethacrylate (PMMA) or other suitable materials such as biologically acceptable metals. The flexible portions of the tubing may be made from silicone rubber or other similar materials. The one-way

check valve may be any of a variety of well known designs which need not be described in detail, but include, by way of example, well known "duck valves".

In use, the physician may surgically implant the device of the invention, as previously described, at the appropriate location in the eye. The second end (13) of the tube (11) may be draped outwardly between the eyelids and affixed for example, to the temple by adhesive tape. When infusion treatment is desired, a suitable infusion fluid source, such as an infusion pump, may be connected to the second end (13) of the tube (11), and the appropriate fluid infused. The fluid source may then be detached from the second end, the check valve preventing escape or reflux of the fluid. After an appropriate period of time, treatment may be repeated. If long term treatment is desired, the device may be provided with the appropriate structure as previously described to allow the entire device to remain within the eye and the cul-de-sac of the conjunctiva. In either case, the device of the invention provides a means for repeatedly introducing appropriate fluids into the eye without causing repeated physical invasions of the eye. The device further provides the flexibility of varying treatment from one time to the next, both as to amount and type, without replacing or disturbing the device.

Referring now to Fig. 6, another embodiment of the invention is depicted. In this drawing, sclera is designated as "S"; the overlying conjunctiva and Tenon's Capsule together is designated "T"; the anterior chamber, "A"; and the cornea "C". For clarity, other structural portions of the eye have been omitted.

This embodiment of the invention provides for fluid dissipation, and includes a housing (130) having walls (135) defining an interior cavity (133) positioned against or adjacent to the outer surface of the sclera "S" beneath the conjunctiva and Tenon's Capsule "T". The housing (130) is desirably made of a pliant material such as silicone rubber, a more rigid polymeric material such as polymethylmethacrylate, an inert metal such as gold, or any other convenient and biologically acceptable material. The housing (130) is typically oval or disk-shaped with a length and width typically in the range of a centimeter or smaller. The housing walls (135) defining the interior cavity (133) have sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted. Located in the housing walls (135) are orifice means (145), such as small holes with diameters of at least 0.25mm that permit fluid transfer from within the interior cavity to fluid resorptive tissues (116) of the eye. The fluid resorptive tissues (116) include the sclera "S" as well as conjunctiva "T" and other adjacent tissues of the eye.

The orifice means (145) described above may include any of a variety of openings that may be located in the housing walls (135). It may be the mouth (146) of the cavity, a hole in the housing wall, (135) or multiple holes in the housing walls (135). When the device is implanted the conjunctiva and Tenon's Capsule "T" lying over the upper walls (135) of the housing do not attach to the housing (130). For this reason a space (114) exists between the tissue and the housing (130) so that, ideally, fluid flowing out of the housing (130) can envelop the housing (130), maximizing the surface area of resorptive tissue (116) available for contact with fluid. The fluid must be able to flow from the cavity to be absorbed by the tissue.

The tissue of the eye will grow around the edges of the opening. If the distance between the closest inner edges of the opening measures less than 0.25mm, the tissue growing into the opening around the edges may be able to contact other tissue and grow together, clogging the orifice means, thus effectively blocking the flow of fluid from the cavity into the surrounding tissue. In order to provide maximum drainage the orifice means should have an effective diameter of at least 0.25mm, preferably at least 0.5mm. (For purposes of this application, an orifice has an "effective diameter" of at least 0.25 mm when the orifice defines an opening extending at least 0.125mm in all directions from a point within the opening; i.e., a circle having a diameter of 0.25mm can be inserted through the orifice.)

Tube means (120) having an inner diameter substantially less than the inner diameter of the cavity (133) communicates at one end (121) with the cavity (133), and at the other end with a fluid source. The fluid source may be an artificial device attached to the eye (such as that shown as (122) in Fig. 6), the anterior chamber (15) of the eye itself, an internal or external drug infusion apparatus or other external devices. The orifice includes a rim having a surface adapted to contact fluid resorptive tissue along a locus of points defining a surface representing the closest approach of fluid resorptive tissue into the cavity. The rim should be located at least approximately 0.25mm, preferably 1.0mm, from the housing end of the tube means.

In a preferred embodiment shown in Figs. 6 and 7, the housing (130) comprises a plate member (134) and a hood member (132) peripherally connected to define an interior cavity having an inner diameter substantially greater than any inner diameter of the tube means therebetween. The plate member (134) desirably is curved to fit snugly against the eye wall. The hood member (132) extends arcuately over the plate member (134) and has a radius of curvature less than the radius of curvature of the eye wall (about 12-15mm) of a

human eye, preferably less than about 8-10mm. The arcuate edge (136) of the hood member (132) typically is rounded so that the tissue of the eye that contacts the hood member, when the device is implanted in the eye, will not be injured by the edge of the hood member. In this embodiment, the orifice means is defined by the space between the plate member and the arcuate edge of the hood member and has an effective diameter of at least about 0.25mm to prevent closure by tissue. The device is implanted so that the plate member (134) contacts the sclera "S", and the exterior of the hood member (132) contacts the conjunctiva and Tenon's Capsule "T".

The plate member (134) desirably is cemented or otherwise attached to a peripheral flange (131). The flange (131) may be of silicone rubber, polymethylmethacrylate or other acceptable polymers, or other convenient biologically acceptable material, and may be fastened to the scleral wall by sutures or other means. The flange (131) may have perforations (138) to receive sutures or to permit tissue ingrowth or both.

The tube means (120) preferably includes a unidirectional check valve as shown in Fig. 13 to permit fluid to flow only toward the interior cavity (133) of the housing (130) only. In the device shown in Figs. 6 and 7, the tube means (120) can establish communication with the interior cavity (133) from any position as long as the end (121) (i.e., the last portion of the tube means that has an inner cross sectional area that is substantially equal to the inner cross-sectional area of the rest of the tube means) remains at least about 0.25mm away from the orifice rim.

In another embodiment of the device shown in Figs. 8 and 9, the housing (130) comprises a hood member (132) having a maximum radius of curvature less than the radius of curvature of the eye wall of the human eye. The hood member (132) will thus be concave and will define an interior cavity (133) having an inner diameter substantially greater than any inner diameter of the tube means which extends between the scleral wall (112) and the interior walls of the hood member. The peripheral edge of the hood member (132) will be attached to the scleral wall. The orifice means (145) in this embodiment is defined by the inner peripheral edge (147) of the walls of the hood member, the sclera "S" of the eye providing the resorptive tissue interface to allow fluid absorption. A peripheral flange (121) may be peripherally cemented or otherwise attached to the edge of the hood member (132), or the hood member (132) may itself have a flat surface around its peripheral edge so that the hood member may be attached to the scleral wall "S" of the eye forming an interior cavity (133) within the walls (135) of the hood. Attached to an

inner wall of the hood member (132) may be a plate member (134) that would permit the housing end of the tube means (120) to communicate with the cavity (133) and yet be spaced at least about 0.25mm from the sclera "S" or any other resorptive tissue in any direction. Although a plate member is shown, it would not be necessary if the tube means end communicates with the housing from the top or sides as long as the end of the tube means is kept at least about 0.25mm from the sclera.

In yet another embodiment of the invention shown in Figs. 10 and 11, the housing (130) comprises a plate member (134), preferably oval or disk-shaped, having a peripheral edge to which a plurality of support structures (155) are attached. The support structures extend arcuately over the plate member and meet in a common point, defining an interior cavity (133). This device resembles a cage. The support structures (155) are of sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted, i.e., although the housing may undergo some deformation, the cavity and orifice means remain open and the 0.25mm limitation with respect to the orifice means are continuously met. The open space between support structures (155) must have an effective diameter of at least about 0.25mm to prevent tissue overlying the support structures (155) from forming a bridge between the support structures (155) thereby clogging the drainage area. The tube means (120) should communicate with the housing in such a way that the support structures (155) will protect the tube means (120) from contacting resorptive tissue of the eye, thus preventing tissue from growing over the tube end and preventing fluid flow. In other words, the rim of the orifice means (the space between support structures) must be at least about 0.25mm away from the housing end of the tube means.

In still another embodiment of the invention shown in Fig. 12, the housing may be an extension of the tube means. In this device the housing has walls that define a cavity having an inner diameter substantially greater than any inner diameter of the tube means and orifice means, the cavity and the orifice having a cross-sectional area available for fluid flow substantially greater than that of the interior of the tube means. The housing walls extending from the walls of the tube means must have sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted. Orifice means located in the housing walls must have an effective diameter of at least about 0.25mm, and the rim must be at least about 0.25mm away from the end of the tube means.

The fluid dissipation device depicted in Figures 6-13 may be used with any fluid delivery system in the eye, including infusion systems and ocular pressure relief systems such as that shown in my U.S. Patent 4,554,918.

Other types of housings may also be used so that the dissipation device serves the same purpose of protecting the end of the tube means from being clogged through contact with tissue of the eye. Such variations may include a device in which the tube means separates into two separate portions at the housing end so that there are two or more ends located within the housing. Typically the two ends will form a "T" within the housing of the device. Other variations will be apparent to the skilled artisan.

While a preferred embodiment of the present invention has been described, it should be understood that various changes, adaptations and modifications may be made therein without departing from the spirit of the invention and the scope of the appended claims.

Claims

1. An infusion cannula for delivering fluids into cavities of an eye, comprising a tube having first and second ends and a check valve therebetween for allowing fluid flow only toward said first end; means for securing the first end within the eye; and means at said second end for attaching the cannula to a fluid source.

2. The infusion cannula of Claim 1 further comprising a compressible reservoir interposed between said check valve and said second end for receiving infusion fluid.

3. The infusion cannula of Claim 1 wherein the attaching means comprises a rubber plug for receiving therethrough a hypodermic needle.

4. The infusion cannula of Claim 1 further comprising a flange extending radially outwardly from the tube near its first end, the flange being attachable to the eye.

5. The infusion cannula of Claim 1 wherein the attaching means comprises a hilt for receiving infusion tubing.

6. The infusion cannula of Claim 1 further including a fluid dissipating device at the first end of the cannula, the device comprising a housing having walls defining an interior cavity and having sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted, the walls further defining outwardly open orifice means to allow fluid to flow from within the cavity directly into liquid absorbing proximity with liquid absorbent

tissue, the cavity having an inner diameter substantially greater than any inner diameter of the cannula.

7. The device of Claim 6 wherein the orifice means has an effective diameter of at least about 0.25mm.

8. The device of Claim 7 wherein the orifice means include a rim having a surface adapted to contact fluid resorptive tissue along a locus of points defining a surface representing the closest approach of fluid resorptive tissue into the cavity.

9. An infusion cannula for delivering fluids into cavities of an eye, comprising a tube having first and second ends, a check valve disposed within the tube between said first and second ends; a compressible reservoir interposed between said check valve and the said second end for receiving infusion fluid; means for securing the first end within the eye and including a flange extending radially outwardly of the tube near its first end, the flange being attachable to the eye; and means at said second end for attaching the cannula to a fluid source.

10. A method of infusing fluid into an eye comprising the steps of:

providing an infusion cannula having first and second ends and a check valve therebetween to allow fluid flow only toward the first end;

surgically inserting the first end of the cannula into the eye;

attaching a fluid source to the second end of the cannula;

delivering fluid into the cannula; and

detaching the fluid source from the second end of the cannula, whereby the check valve will prevent reflux of fluid through the cannula.

11. The method of Claim 10 wherein the insertion step includes the step of inserting the first end of the cannula through the wall of the eye into the vitreous cavity.

12. The method of Claim 10 further comprising the step of providing a compressible reservoir in fluid communication with the tube and disposed between the check valve and said second end, the infusing step including the steps of infusing fluid into the reservoir.

13. The method of Claim 10 wherein the first end of the cannula is inserted into orbital spaces outside of the vitreous cavity.

14. A tissue implantable, fluid-dissipating device comprising: a housing having walls defining an interior cavity, the housing walls having sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted and defining outwardly open orifice means to allow fluid to flow from within the cavity directly into liquid absorbing proximity with liquid absorbent tissue; and tube means communicating with the cavity for conduct-

ing fluid into the cavity the cavity having an inner diameter substantially greater than any inner diameter of the tube means.

15. The device of Claim 14 wherein the orifice means has an effective diameter of at least about 0.25mm.

16. The device of Claim 15 wherein the orifice means include a rim having a surface adapted to contact fluid resorptive tissue along a locus of points defining a surface representing the closest approach of fluid resorptive tissue into the cavity.

17. The device of Claim 16 wherein the rim of the orifice means is positioned at least about 0.25mm from the end of the tube means communicating with the cavity, to prevent eye tissues from growing into the tube means end.

18. The device of Claim 15 wherein the housing comprises a plate member and a hood member peripherally connected to the plate member define the interior cavity.

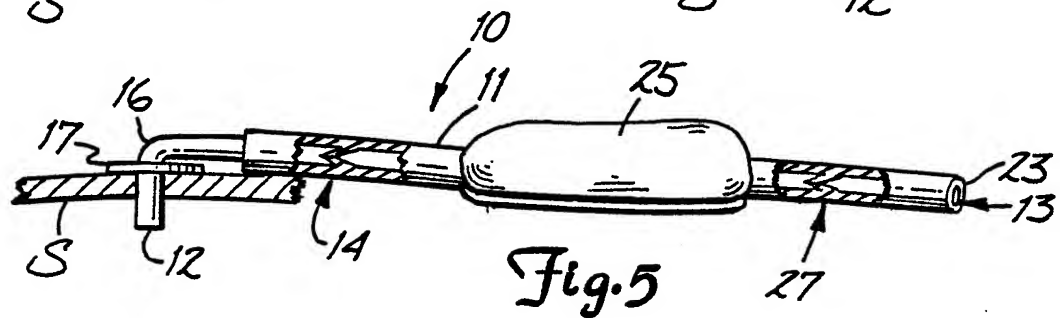
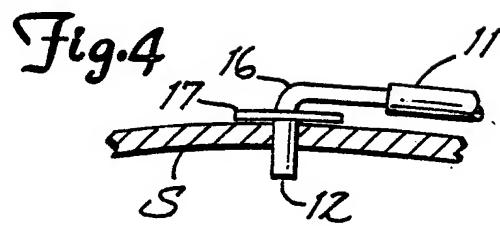
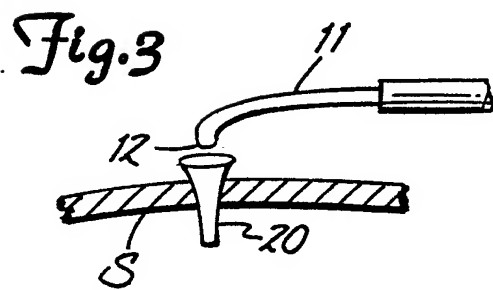
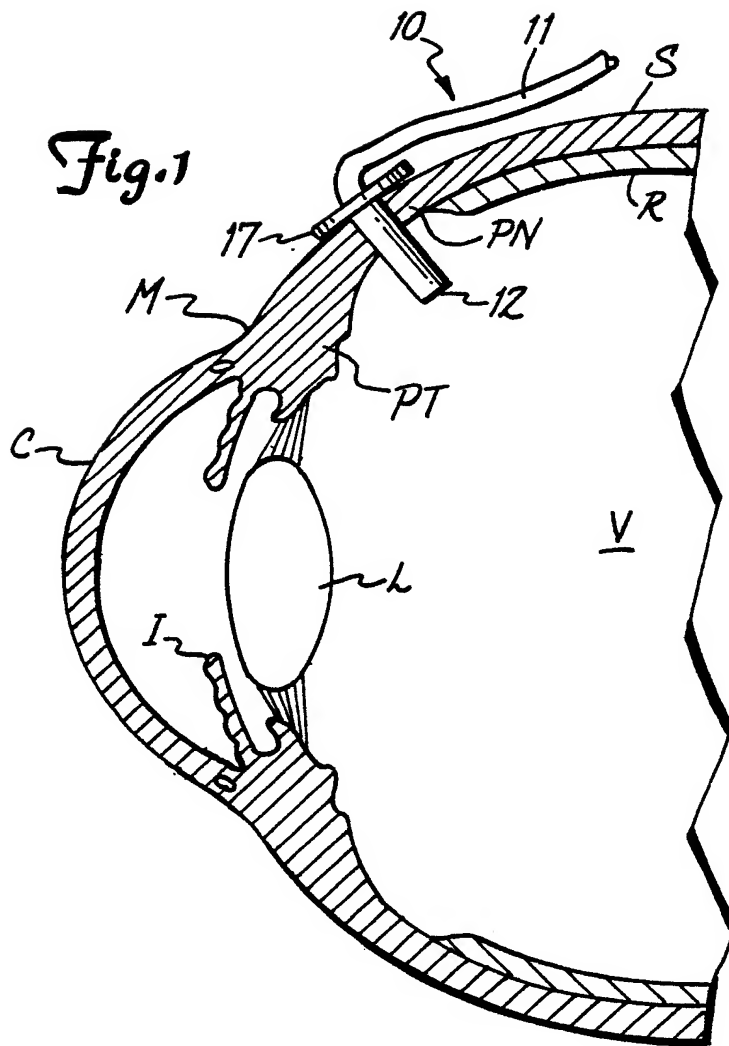
19. The device of Claim 14 wherein the tube means includes check valve means restraining liquid flow to a direction away from the tube means.

20. A tissue-implantable, fluid-dissipating device comprising: a curved housing having a peripheral portion and a central portion having a radius of curvature which is substantially less than the radius of the curvature of a human eye, resulting in the formation of a cavity between the eye wall and housing when the housing peripheral portion is in contact with the eye wall; attachment means carried by the housing to the eye wall; and tube means communicating with the housing for delivering fluid into the housing.

21. The device of Claim 20 wherein the surface area of the eye wall comprising fluid resorptive tissue within the housing has an effective diameter of at least about 0.25mm.

22. A tissue-implantable fluid-dissipating device comprising: a housing comprising a generally annular plate member and a plurality of support structures attached to the peripheral edge of said plate member at an end and extending arcuately over said plate member to define an interior cavity therebetween, said support structures having sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted; orifice means having an effective diameter of at least approximately 0.25mm and including a rim having a surface adapted to contact fluid resorptive tissue along a locus of points defining a surface representing the closest approach of fluid resorptive tissue into the cavity; and tube means communicating with the cavity for conducting fluid into the cavity, the housing end of the tube means positioned at least about 0.25mm away from the rim of the orifice means.

23. A tissue-implantable fluid-dissipating device comprising a housing having walls defining an interior cavity, the housing walls having sufficient rigidity to prevent substantial collapse of the cavity when the device is implanted, outwardly open orifice means to allow fluid to flow from within the cavity into liquid absorbing proximity with liquid absorbent tissue, expandable, compressible reservoir, and tube means communicating the reservoir with the cavity to allow fluid to flow from the reservoir into the cavity.



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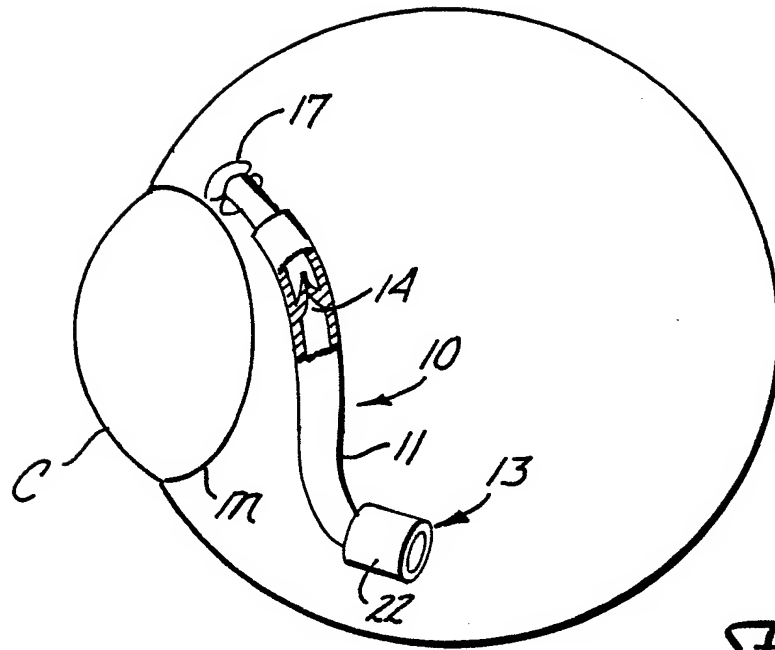


Fig. 2

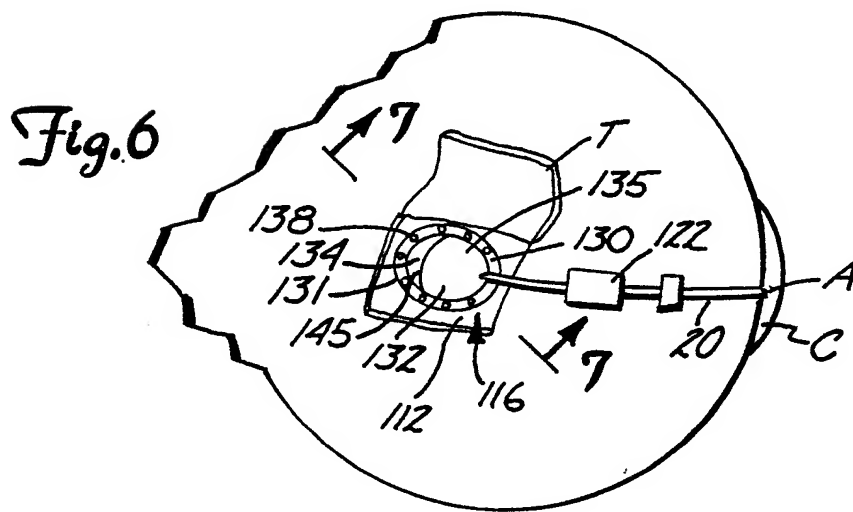


Fig. 6

Fig.7

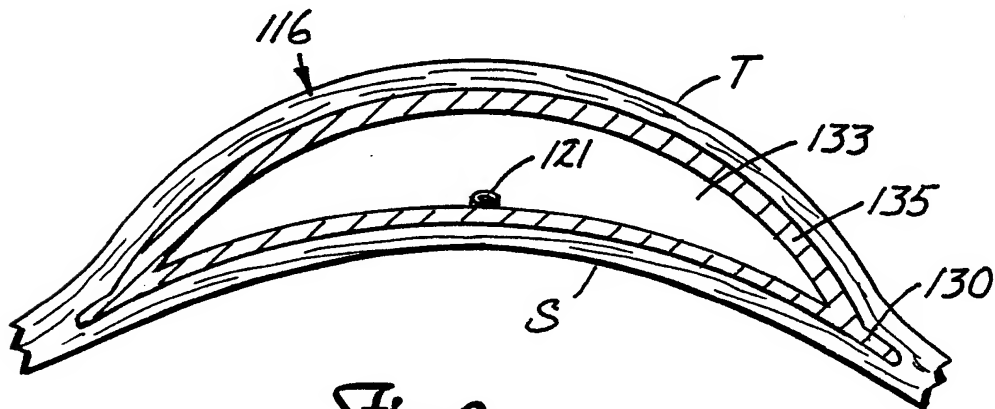
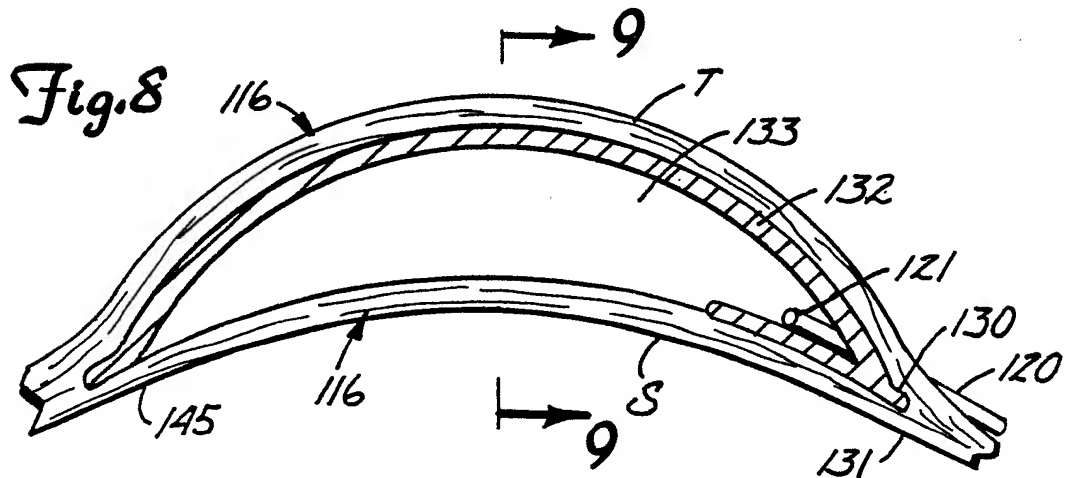
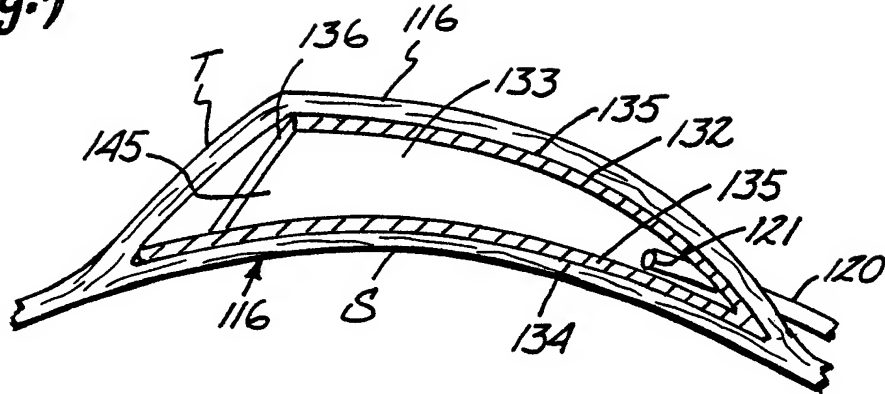


Fig.9

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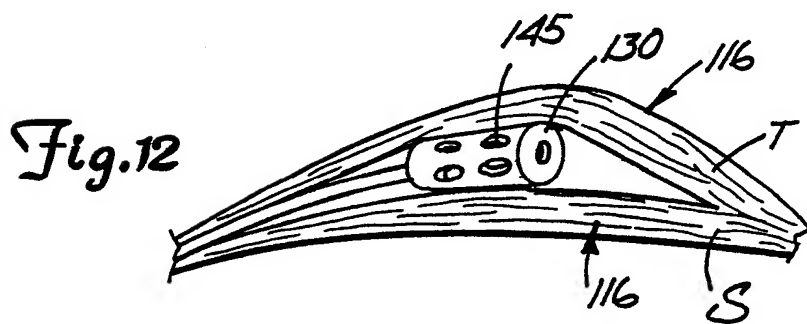
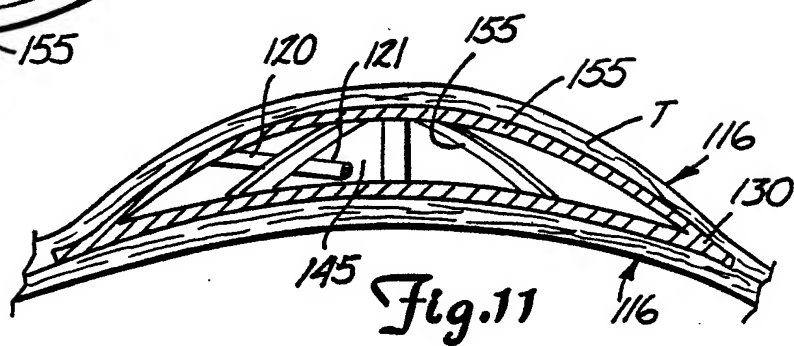
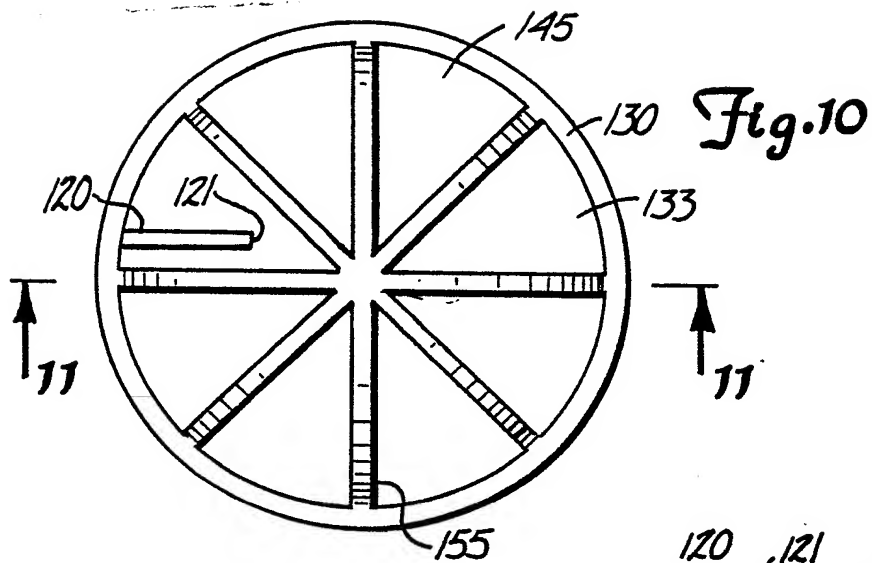
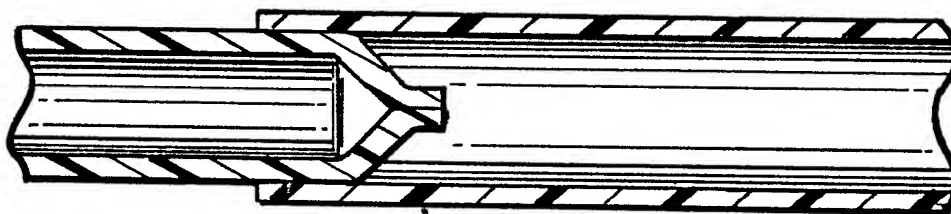


Fig. 13





DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
D, Y	US-A-4 554 918 (WHITE) * claim 1; figures 1-4 *	1	A 61 F 9/00
Y	--- SOVIET INVENTIONS ILLUSTRATED, Section Mechanical, Week K42, 30th November 1983, abstract no. 83-793260 P32, Derwent Publications Ltd., London, GB; & SU - A - 980 711 (TURK EYE DISEASES) 15-12-1982	1	
A	--- US-A-3 788 327 (DONOWITZ et al.) * figures 1, 4 *	1	
A	--- US-A-4 240 434 (NEWKIRK) * claim 1; figure 1 *	1	TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
A, P	--- FR-A-2 569 987 (SIGMA) * figures 1-3; claim 1 * -----	1, 2	A 61 F 9/00 A 61 M 1/00 A 61 M 31/00
The present search report has been drawn up for all claims			
Place of search BERLIN		Date of completion of the search 10-03-1987	Examiner KANAL P K
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>			